

Differential Terahertz Imaging Methods for Enhanced Detection of Subsurface Features, Flaws, and Damage, Phase I

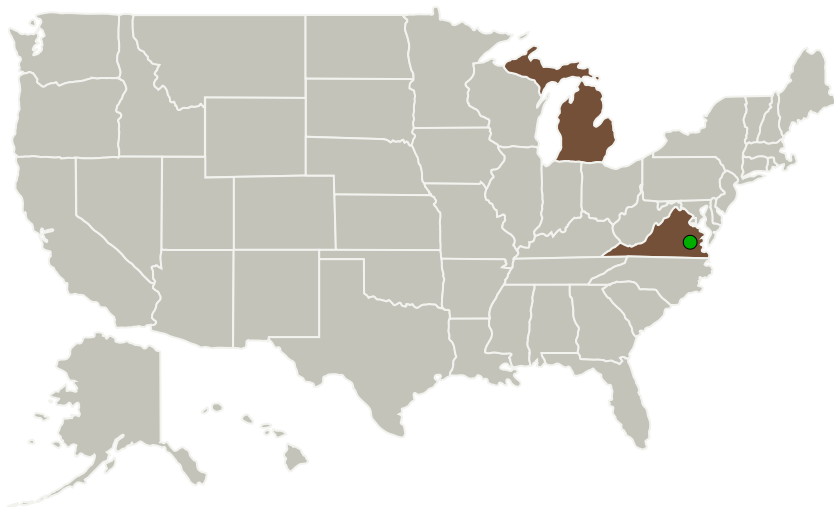
Completed Technology Project (2016 - 2016)



Project Introduction

Picometrix proposes to demonstrate the feasibility of using differential time domain terahertz imaging methods to enhance the contrast and detectability of features such as kissing disbonds and cracks that in conventional THz imaging only weakly reflect or scatter the THz pulses. The goal of the project is to develop methods of shearographic loading of the samples, and use the penetrating THz pulses to detect the subsurface deformation of the defects in the differential THz images with better contrast than traditional THz imaging. In a "kissing" disbond there is a region where the two sides of the material are not adhered, but the space between the two sides are essentially in perfect optical contact. When the space between the two interfaces is so optically "thin," the reflections of the THz pulses from the top and bottom surfaces cancel each other out. The defect signature is only weakly detectable compared to when the spacing is greater than the minimum THz wavelength (approx. 50-150 microns), the shearographic loading will microscopically deform defects, changing the small THz reflections in the loaded vs. unloaded state. The differential images should subtract all background clutter and highlight the microscopic subsurface distortion of the defects under loading.

Primary U.S. Work Locations and Key Partners



NASA SBIR/STTR Technologies

Proposal No. H13.02-1009 Non-Destructive Evaluation (NDE) Sensor:
**Differential Terahertz Imaging Methods for
Enhanced Detection of Subsurface Features, Flaws, and Damage**
PI: David Zandbergen, Picometrix, LLC, Ann Arbor, MI

Identification and Significance of Innovation

- CHIRP is a proven aerospace sub-surface inspection technology, has been used on Space Shuttle and Orion TPS.
- Some reported types of material defects such as "kissing" disbonds and cracks in optical contact may have poor contrast and detectability in traditional THz imaging.
- Differential imaging with shearographic loading may increase contrast of these defects. Static background is zeroed out.
- This detects the subsurface deformation that may not reach the surface in traditional optical interference shearography.

Phase I: TRL Start 2, End 4

Phase I: Technical Objectives and Work Plan

- Design, construct, and obtain samples, incorporate disbond and cracks.
- Configure a small CHIRP ray (500 THz) range to gently load for THz reflection tomography imaging.
- Conduct shearographic loading device and vacuum pressure chamber, thermal heating, synchronous image capture and display.
- Collect reference and shearographically loaded/unloaded THz images.
- Alter difference images and compare the contrast of the defects to the traditional THz images.
- Report and describe Phase I prototype configuration.

NASA and Non-NASA Applications

- Inspection of composite aerospace components during manufacturing and after aging.
- Material samples include Kevlar, Zylon, glass, and other non-conductive polymer matrix composites.
- Inspect ablative thermal protection systems, foam (DOF), T-UP, Sun shield for containment, and composite overwing pressure vessels, inflatable habitats.
- Inspect insulation, plastic sheets, foam sheets, paper, wiring material for deterioration during manufacturing.

Form/Contact

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NON-PROPRIETARY DATA

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Organizations Performing Work	Role	Type	Location
Picometrix, LLC	Lead Organization	Industry	Ann Arbor, Michigan
● Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
Michigan	Virginia

Project Transitions

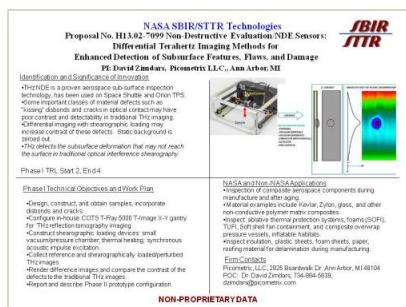
June 2016: Project Start

December 2016: Closed out

Closeout Documentation:

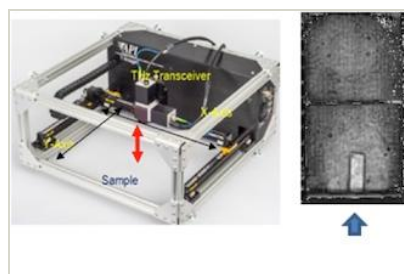
- Final Summary Chart(<https://techport.nasa.gov/file/140422>)

Images



Briefing Chart Image

Differential Terahertz Imaging Methods for Enhanced Detection of Subsurface Features, Flaws, and Damage, Phase I
(<https://techport.nasa.gov/image/130934>)



Final Summary Chart Image

Differential Terahertz Imaging Methods for Enhanced Detection of Subsurface Features, Flaws, and Damage, Phase I Project Image
(<https://techport.nasa.gov/image/125907>)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Picometrix, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

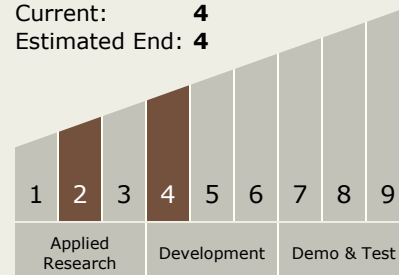
Carlos Torrez

Principal Investigator:

David Zimdars

Technology Maturity (TRL)

Start: 2
Current: 4
Estimated End: 4



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Technology Areas

Primary:

- TX08 Sensors and Instruments
 - └ TX08.1 Remote Sensing Instruments/Sensors
 - └ TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System